RQ20-52

1. **Research Title:** *Autonomous Aircraft Structural Layout and Topology Optimization using Parametric Geometry Coupled with a Finite Element Method*
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**
   Mechanical Engineering or Aerospace Engineering (MS or Ph.D. level)
4. **Objectives:** The objective of the proposed thesis research is to develop an approach for the autonomous layout of an optimized internal aircraft structure (ribs, spars, bulkheads, stringers, etc.). Optimization and layout of the internal structural would be completed using parametric geometry coupled with a Finite Element Method (FEM), and additional design constraints such as volume, weight, etc. In conjunction with the autonomous internal structural layout and optimization, the structural members would need to undergo topology and gauge thickness optimization during the layout process. The resulting approach and methods would then need to be demonstrated, verified, and validated using known vehicle wing, fuselage, or entire vehicle internal structural designs and testing results. Ideally they would be compared to previously optimized structures.
5. **Description:** The feasibility of incorporating aircraft structural design early into the aircraft design process is significantly increasing with the increasing power of computational structural mechanics. Aircraft structural design is typically not addressed until later in the aircraft design process. This can detrimentally affect the aircraft vehicle design, resulting in negative cost, schedule, and performance impacts to the program. Current research has shown that structural topology optimization can be performed using various methods to create optimized aircraft structural members. These results from topology optimization research need to be coupled with an optimized autonomous internal aircraft structural layout. Utilizing shell finite elements with parametric geometry allows this structural layout and analysis to be potentially performed early in the aircraft design. The resulting developed approach and methods would be ideally used at a pre-Conceptual Design Review (CoDR) vehicle design level. Additionally, these methods could eventually be used to layout the initial aircraft internal structural design. Tools available within RQH include Engineering Sketch Pad (ESP) and Vehicle Sketch Pad (VSP) for parametric geometry generation. For FEM simulations, RQH has licenses to Abaqus in addition to the research code, Albany, from Sandia National Laboratories. Other geometry and FEM packages can be used and the research activity is not constrained by these choices.
6. **Research Classification/Restrictions:** U.S. Citizens only. Most aspects of this research fall under the 6.1 basic research classification. However, some aspects, in particular those dealing with specific vehicle configurations and performance parameters, are FOUO with ITAR restrictions.

7. **Eligible Research Institutions:**

DAGSI (Wright State University, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati) NOTE: Topics submitted to DAGSI must be approved for public release.